

CLAIMS

- 1 1. A method of deblurring an image, comprising the steps of:
2 downloading a blurred image having pixels into a systolic array
3 processor, said processor comprising an array of processing logic blocks
4 such that groups of pixel arrive in respective processing logic blocks;
5 sequentially exchanging data between processing logic blocks by
6 interconnecting each processing logic block with a predefined number
7 of the processing logic blocks adjacent thereto; and
8 uploading the deblurred image.
- 1 2. The method of claim 1, wherein said processing logic blocks
2 providing an iterative update of said blurred image by (i) providing
3 feedback of the blurred image prediction error using the deblurred
4 image and (ii) providing feedback of the past deblurred image estimate.
- 1 3, The method of claim 1, wherein said iterative update is
2 implemented in said processing logic blocks by $u(n+1) = u(n) - K^*(H$
3 $* u(n) - y_b) - S^* u(n)$ where u is the ideal undistorted image, m and n
4 are column and row indices of an image pixel element, $y_b(m, n)$ is the
5 observed blurred image, $*$ denotes a 2-D convolution, K is a feedback
6 update operator with a convolution kernel $K(m, n)$ and S is a smoothing
7 operator with a convolution kernel $S(m, n)$.
- 1 4. The method of claim 1, wherein said iterative update is
2 implemented in said processing logic blocks by $u(n+1; c) = u(n, c) - K$

3 $\cdot (H \cdot u(n, c) - y_b(c)) - S \cdot u(n, c)$ where $y_b(c) = y_d(j, k, c)$ is the 2-D
 4 array of color c intensities for the blurred image encompassing all pixels
 5 (j, k) in the image and $u(n, c) = u(j, k, n, c)$ is the 2-D array of color c
 6 intensities for the restored image estimates at iteration number n

1 5. The of claim 1, wherein said processor groups pixel in groups that
 2 comprises at least one pixel.

1 6. The method of claim 5, wherein said groups of pixels comprises a
 2 group selected from 2 by 2 pixels, 3 by 3 pixels, and 4 by 4 pixels.

1 7. A device for deblurring an image, comprising:
 2 an blurred image source having pixels;
 3 a systolic array processor adapted to download said blurred image,
 4 said processor comprising an array of processing logic blocks such that
 5 groups of pixels arrive in respective processing logic blocks;
 6 said processor being adapted to sequentially exchange data
 7 between processing logic blocks by interconnecting each processing
 8 logic block with a predefined number of the processing logic blocks
 9 adjacent thereto; and
 10 said processor including an upload for the deblurred image.

1 8. The device of claim 7, wherein said processor is adapted to
 2 process logic blocks to provide an iterative update of said blurred image
 3 by (i) providing feedback of the blurred image prediction error using the

4 deblurred image and (ii) providing feedback of the past deblurred image
5 estimate.

1 9. The device of claim 7, wherein said processor includes an iterative
2 update implemented in said processing logic blocks by $u(n+1) = u(n) -$
3 $K^*(H^*u(n) - y_b) - S^*u(n)$ where u is the ideal undistorted image, m
4 and n are column and row indices of an image pixel element, $y_b(m, n)$ is
5 the observed blurred image, $*$ denotes a 2-D convolution, K is a feedback
6 update operator with a convolution kernel $k(m, n)$ and S is a smoothing
7 operator with a convolution kernel $s(m, n)$.

1 10. The device of claim 9, wherein the operators H , K , and S are
2 preloaded in each of the array processing logic blocks.

1 11. The device of claim 7, wherein said iterative update is
2 implemented in said processing logic blocks by $u(n+1; c) = u(n, c) - K$
3 $^*(H^*u(n, c) - y_b(c)) - S^*u(n, c)$ where $y_b(c) = y_d(j, k, c)$ is the 2-D
4 array of color c intensities for the blurred image encompassing all pixels
5 (j, k) in the image and $u(n, c) = u(j, k, n, c)$ is the 2-D array of color c
6 intensities for the restored image estimates at iteration number n .

1 12. The device of claim 7, wherein said processor groups pixel in
2 groups that comprises at least one pixel.

1 13. The device of claim 12, wherein said groups of pixels comprises a
2 group selected from 2 by 2, 3 by 3 and 4 by 4 pixels.

1 14. A device for deblurring an image, comprising:

2 image means for providing a blurred image having pixels;

3 systolic array processor means for processing said blurred image
4 and adapted to download said blurred image, said processor means
5 comprising an array of processing logic block means for processing
6 groups of pixels in respective processing logic blocks;

7 said processor means being adapted to sequentially exchange data
8 between processing logic block means by interconnecting each
9 processing logic block means with a predefined number of the
10 processing logic block means adjacent thereto; and

11 said processor means including means for uploading the
12 deblurred image.

1 15. The device of claim 14, wherein said processor means is adapted
2 to process logic blocks to provide an iterative update of said blurred
3 image by (i) providing feedback of the blurred image prediction error
4 using the deblurred image and (ii) providing feedback of the past
5 deblurred image estimate.

1 16. The device of claim 15, wherein said processor includes means an
2 iterative update implemented in said processing logic block means by
3 $u(n+1) = u(n) - K^*(H^*u(n) - y_b) - S^*u(n)$ where u is the ideal

4 undistorted image, m and n are column and row indices of an image
 5 pixel element, $y_b(m, n)$ is the observed blurred image, $*$ denotes
 6 convolution, K is a feedback update operator with a convolution kernel
 7 $K(m, n)$ and S is a smoothing operator with a convolution kernel $S(m, n)$.

1 17. The device of claim 16, wherein the operators H , K and S are
 2 preloaded in each of the array processing logic blocks.

1 18. The device of claim 15, wherein said iterative update is
 2 implemented in said processing logic blocks by $u(n+1; c) = u(n, c) - K$
 3 $\cdot (H \cdot u(n, c) - y_b(c)) - S \cdot u(n, c)$ where $y_b(c) = y_d(j, k, c)$ is the 2-D
 4 array of color c intensities for the blurred image encompassing all pixels
 5 (j, k) in the image and $u(n, c) = u(j, k, n, c)$ is the 2-D array of color c
 6 intensities for the restored image estimates at iteration number n

1 19. The device of claim 14, wherein said processor groups pixel in
 2 groups that comprises at least one pixel.

1 20. The device of claim 19, wherein said groups of pixels comprises a
 2 group selected from 2 by 2, 3 by 3 and 4 by 4 pixels.